Glazing

This invention relates to glazing panels and particularly, but not exclusively, to glazing panels which are intended to provide a degree of fire protection or fire screening.

A fire screening glazing panel preferably fulfils a number of separate functions. These may include:

- resisting breakage and/or collapsing when exposed to fire so as to provide a physical barrier to smoke, hot gasses and flames;
- providing a barrier to the propagation of heat from a fire so as to provide a passageway on the fire protected side of the glazing which can be used to evacuate a building and/or so as to reduced the risk of spontaneous combustion of flammable materials on the fire protected side.

Building codes define degrees of fire shielding required for different building applications.

According to one aspect, the present invention provides a glazing panel as defined in Claim 1.

The maximum heat release rate of the interlayer may be less than 600, 550, 500, 450 or 400 kW/m^2. The maximum heat release rate may be determined by subjecting a sample of the interlayer material to a test in accordance with International standard ISO 5660-1 and measuring the heat release rate as a function of time. This may then be expressed as heat release rate per m^2 of interlayer and the maximum heat release rate in KW/m^2 may be determined.

Although a laminating interlayer for example of PVB may be used to provide a glazing with a certain mechanical resistance, such interlayers have generally been considered disadvantageous to the performance of glazing panels in fire test situations. Such materials are prone to combust, to loose their integrity and to deteriorate the glazing performance in a fire test.

In order to perform a pendulum test according to European Standard EN12600, it is generally necessary to test a glazing sample having dimensions of 876 mm by 1938 mm (±2mm). In the context of the present invention, the rating of a glazing panel according to this standard may be assessed for a glazing panel which does not have the appropriate dimensions by cutting the glazing panel to the appropriate size if possible or assessing the rating according to the test of a sample glazing having an appropriate size and having the same structure (for example being sold as the same product) as the glazing panel in question.

One aspect of the invention is at least partially based on the following reasoning developed by the inventors:

- if the effect of the interlayer material during fire exposure can be controlled so that it does not significantly deteriorate the glazing panel's fire performance (even if the laminating interlayer does not contribute significantly to the fire performance) then a satisfactory level of fire performance may be achieved
- ensuring that the rate at which heat is released from a laminating interlayer when a glazing panel is exposed to fire conditions is sufficiently low so as to avoid creating a rapid additional release of heat which may be detrimental to the fire performance of the glazing panel may prevent the laminating interlayer from having a significant negative effect on fire performance
- such an interlayer may in addition contribute to a desired level of mechanical resistance
- even a modest improvement in fire performance may be significant if, for example, it allows a glazing panel to cross the threshold required for a particular fire rating.

Mechanical resistance of a glazing panel may be assessed as set out in European Standard EN12600 (often referred to as the pendulum test). Glazings in accordance with various aspects of the invention may have a rating of 2B2 or preferably 1B1 according to this standard.

Glazings in accordance with various aspects of the invention may have fire ratings of at least E15, E20, E30, E45, E60, E90, E120, EW15, EW20, EW30, EW45, EW60, EW90, EW120, EI15, EI20, EI30, EI45, EI60, EI90 or EI120 as defined according to European Standards EN 1363 and EN 1364, particularly EN1364-1 . References herein to fire ratings and/or performance in fire tests are made with respect to these standards.

The invention may allow a glazing panel having, for example, dimensions of at least 0.4m by 0.4m, 0.4m by 0.5m, 0.5m by 0.5m, 0.5m by 0.6m, 0.6m by 0.6m, 0.6m by 0.7m, 0.7m by 0.7m, 0.7m by 0.8m, 0,8m by 0;9m, 0.9m by 0.9m, 0.9m by 1m, 0.9m by 2.2m, or 0.9m by 2.4m, 0.95m by 1.95m, 1m by 2m, 1m by 2.2m, 1m by 2.4m, 1.2m by 2m, 1.2m by 2.2m, , 1.2m by 2.4 m, 1.2m by 2.6m, 1.3m by 2m, 1.3m by 2.2m, 1.3m by 2.4 m, 1.3m by 2.6m, 1.3m by 2.7m, 1.4m by 2m, 1.4m by 2.2m, 1.4m by 2.4 m, 1.4m by 2.6m or 1.4m by 2.7m to have a defined fire resistance.

Glazing panels in accordance with various aspects of the invention are preferably non-wired glazing panels, that is to say, the sheets of glass they contain are not wired glass.

Some or all glass sheets used may be of soda lime glass, preferably float glass. Some or all of the glass sheets may be non-soda lime glass, for example,

glass selected from borosilicate glass, glass having an expansion coefficient less than or equal to 9 x 10^{-6} and glass having a Tg (transformation temperature) greater than or equal to 580°C

In embodiments of the invention which use an intumescent layer, such a layer may have a thickness of less than or equal to 2.5mm, 2mm, 1.9mm or 1.6mm; such an intumescent layer may have a thickness on greater than or equal to 1mm, 1.1mm or 1,2mm. Such a layer preferably has a thickness within the range of 1.2 to 1.6mm. The intumescent layer may comprise or consist essentially of a silicate, for example a potassium silicate or preferably a sodium silicate.

According to another aspect, the present invention provides a glazing panel as defined in Claim 4.

Such fire resistance has not previously been obtainable in such structures. The multiple sheet glazing panel may have a fire resistance of greater than or equal to EW70, EW75, EW80, EW90 or EW100.

The sealed gas filled space may be filled with air or with a gas or mixture of gasses, for example with a gas mixture which increases the heat insulation of the glazing panel.

The following structures according to this aspect of the invention may be particularly advantageous:

- Fire => Annealed Soda Lime glass (4mm)/0.76mm PVB interlayer/ Annealed Soda Lime glass (4mm)/solar control layer/sealed gas space/infra red reflecting layer/Tempered soda lime glass sheet (6mm)
- Fire => Annealed Soda Lime glass (4mm)/0.76mm PVB interlayer/ Annealed Soda Lime glass(4mm) /sealed gas space/ solar control layer/ Tempered soda lime glass sheet (6mm)
- Fire => Annealed Soda Lime glass (6mm)/0.76mm PVB interlayer/ Annealed Soda Lime glass (6mm)/sealed gas space/ solar control layer/ Tempered soda lime glass sheet (6mm)
- Fire => infra red reflective layer/ Annealed Soda Lime glass (4mm)/0.76mm PVB interlayer/ Annealed Soda Lime glass(4mm)/sealed gas space/ solar control layer/ Tempered soda lime glass sheet (6mm)

Where the term "Fire" indicates the orientation of the glazing panel for its fire rating and the coating layers are present as indicated on the adjacent glass surfaces. These structures and others defined in claim 5 may be particularly useful as architectural glazings for external building facades.

The structure: infra red reflecting coating/tempered 6mm glass sheet/sealed gas space/infra red reflecting layer/tempered 6mm glass sheet/0.76mm

PVB interlayer/ tempered 12 mm glass sheet may also be advantageous, with or without variations in the glass thicknesses, for example for maritime applications, particularly external cabin windows. In such applications, the glazing panel may have a surface area of greater than or equal to 0.8 m^2, 1m^2, 1.2m^2, 1.3m^2, 1.4m^2, or 1.5 m^2.

The structures defined in claims 6, 7 and 8 may be particularly suited to interiors architectural glazing panels. The thickness of the glass sheets may be approximately, 3mm, 4mm, 5mm or 6mm, with the individual sheets in each glazing panel having substantially the same thickness or different thicknesses. This structure may be used to provide a range of glazing panels have different total thicknesses and/or different fire ratings.

According to a further aspect, the present invention provides a glazing panel as defined in Claim 9. This may provide an alternative to polished wired glass by providing a desired fire rating in a relatively light structure without the inconvenience of a visible, wire grill embedded in the glazing. These structures may also combine these advantages with a desired level of mechanical resistance.

According to another aspect, the present invention provides a glazing panel as defined in claim 10. As defined by claims 11 and 12, the intumescent layer in such structures may be different from that commonly used in fire rated glazing structures. This may allow the intumescent layer to be optimised, particularly to ensure sealing or gas tightness during a fire test to ensure the integrity of the glazing panel.

The dependent claims define preferred and/or alternative embodiments of the invention.

In various embodiments of the inventions:

- one or more of the glass sheets may be heat tempered, for example with a surface compression of between about 80 MPa and 150 MPa, preferably between about 90 and 110 MPa, for example about 100 MPa
- the infra-red reflectance of the glazing panel in the band of wavelengths 1-10 microns may be at least 60%, 65%, 70% 75%, 80%, 85%, 90% or 95%. This may provide good fire screening properties.
- coating layers may be formed pyrolytically on the glass substrate or by a vacuum technique, for example, by sputtering. In the latter case, the infra-red reflecting material is preferably silver or an alloy containing silver.
- the normal emissivity of the glazing panel and/or of a coating may be less than or equal to 0.2, 0.15, 0.1 or 0.05. Normal emissivity as used herein refers to

the normal emissivity determined in accordance with European standards EN 12898 / EN 673. This may confer good fire resistance.

The following terms used herein have the following meanings, unless the context requires otherwise:

- Infra red reflecting layer means a coating layer selected from the group consisting of : a fluorine doped tin oxide coating; a coating comprising the structure antireflective dielectric layer/infra red reflecting layer/antireflective dielectric layer (for example, the coating stacks TiO_2/Ag/barrier/TiO_2 or TiO_2/Ag/barrier/TiO_2/Ag/barrier/TiO_2); a coating layer having a normal emissivity of less than 0.3, preferably less than 0.2.
- Solar control layer means a coating layer which increases the selectivity (i.e. the ratio of the luminous transmittance to the solar factor) of the substrate to which it is applied.

The Luminous transmission of the glazing panel (i.e. the luminous flux transmitted through a substrate as a percentage of the incident luminous flux) may be, for example, greater than 15%, 30%, 50%, 60% or 70%.

The energetic transmission of the glazing panel (i.e. the solar flux (luminous and non-luminous) transmitted through a substrate as a percentage of the incident solar flux) may be les than or equal to 70%, 65%, 60%, 55%, 50%, 45% or 40%.

The total UV transmittance of a glazing panel according to at least some embodiments of the invention measured according to European standard EN410 may be less than 5%, 2% or 1% and is preferably less than 0.5%.

Examples of the present invention will now be described by way of example only, with reference to:

FIG 1 which is a cross section of a glazing panel according to one embodiment the invention; and

FIG 2 which is a cross section of a glazing panel according to another embodiment of the invention

The glazing panel 10 of FIG 1 comprises the following elements:

- a first glass sheet 1
- a second glass sheet 2
- a third glass sheet 3
- 0.76mm thick interlayer of PVB 4 assembled between the first 1 and second 2 glass sheets

- a 15 mm wide sealed gas containing enclosure 5, having a spacer 6 running around its periphery arranged between the second 2 and third 3 glass sheets.

The first 1 and second 2 glass sheets are approximately 4mm thick and are made of annealed, soda lime glass. The third glass sheet 3 is approximately 6mm thick and is made of tempered soda lime glass having a surface compression at a central portion of about 100 MPa.

Face five F5 of the glazing panel on the third sheet of glass 3 carries a coating stack which provides solar control and infra red reflection properties (not shown) and which consists of the structure from the glass sheet of: antireflective dielectric layer/Ag/barrier/antireflective dielectric layer/Ag/barrier/antireflective dielectric layer.

The PVB interlayer has a maximum heat release rate of about 425 kW/m^2 when measured in the way previously referred to.

The glazing panel has dimensions of approximately 1m x 1.5m and has a fire rating of EW60 when the first sheet of glass 1 is exposed to a heat source during a fire test. The glazing panel has a mechanical resistance of 2B2 in the punching bowl test with impact of the punching bow arranged against the first glass sheet.

The glazing panel 20 of FIG 2 comprises the following elements:

- a first glass sheet 21
- a second glass sheet 22
- a third glass sheet 23
- 1.6 mm thick intumescent layer 24 comprising a sodium silicate assembled between the first 21 and second 22 glass sheets
- a 0.76 mm thick PVB interlayer 25 arranged between the second 22 and third 23 glass sheets.

Each of the first 21, second 22 and third 23 glass sheets are approximately 2mm thick and are made of annealed, soda lime glass.

The PVB interlayer has a maximum heat release rate of about 425 kW/m^2 when measured in the way previously referred to.

The glazing panel has dimensions of approximately 1m x 1.5m and has a fire rating of EW30 when the first sheet of glass 1 is exposed to a heat source during a fire test. The glazing panel has a mechanical resistance of 2B2 in the punching bowl test with impact of the punching bow arranged against the third glass sheet.